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POLLINATION BIOLOGY OF SOUR CHERRY VARIETIES OF PROTOGYN BLOSSOMING

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Abstract

Protogyny as one type of dichogam mechanisms supposes mostly autosterility. Yet in sour cherry varieties protogyny occurs both in autosterile and autofertile types. In some of the autosterile types the receptivity of stigma and the phase of opening of anthers is totally separated. A true dichogamy is indicated by a 12 hour periodicity of nectar secretion and the degeneration of stigma papills in the young opened flower. In the phase of opening of anthers the 12 hour diurnal rhithm of nectar production remains, but it is shifted by 6 hours. In the autofertile types protogyny is indicated by the stigma exerted or by the stigma of pollination chamber which is accompanied by a 12 hour secretion rhithm characteristic for dichogamy. Protogynous flowers waiting for extraneous pollination at the beginning of blossoming avoid selfpollination by dichogamy, but during the opening of anthers they become homogamious indicated by a nectar secretion rhithm with 6 hour periodicity and by the delayed receptivity of stigma. Such "delayed" homogam flowers can be fertilized by self pollination at the end of blossoming. The changing of pollination strategy is characteristic for the protogyn sour varieties: 1. stigma exerted – wind pollination, 2. state of pollination chamber – beetle pollination, 3. opening of anthers – pollination by bees and other insects.

Key words: sour cherry varieties, sour cherry pollination biology, protogyny, periodicity of nectar secretion.

Introduction

Most of the authors describe protogyny as a dishogam mechanism which excludes self-pollination (STOUT, 1928, SCHROEDER, 1943; SPENCER–KENNARD, 1955; THIEN, 1974; SEDLEY, 1977). In their opinion the protogynous flower is pollinated or in green bud stage, in stigma exerted stage streaching out of the green bud, or one day after the opening of the flower. PILJ (1961) and GOTTSBERGER (1974, 1977) emphasize the importance of cantharophyly, the pollination chamber stage and the role of beetle pollination in the pollination of protogyn *Prunus* and *Pyrus* types showing a secondary polyandry. Studying the turgorous stae of cherry, plum and apple stigma papillies STÖSSER (1985) considered the day of blossoming as optimal from the point of view of pollination.

The flowers of sour cherry varieties were described by Mohácsi and Maliga (1956) as protogyn. Their observations were supported by Nyéki (1974), but he experienced homogamy too. Proterandry is rare in sour cherry varieties, but this phenomenon was found in one case (Orosz Kovács et al., 1987). In Pejkic's opinion receptivity of stigma in Pándy sour cherries lasts for 1—2 days after blossoming. Nyéki and Ifjú (1975) discovered that the stigma secretion activity and the daily rhithm of the opening of anthers are different in the varieties studied by them.

A summary about the control of floral nectar secretion is given by Bently and Elias (1983). The periodicity of nectar production of *Prunoideae* taxons and the synchronization of the endogen rhithm with stigma receptivity and anther dehiscence were studied by Orosz Kovács (1988, 1990), Orosz Kovács et al. (1987, 1988, 1989), Majer Bodrács et al. (1989). They found that dichogam flowers produce nectar periodically by 12 th hours, the homogam ones by 6 th hours, and the time of maximum production is synchronized by the stigma receptivity and anther dehiscence. When studying the periodicity of nectar production of the Pándi sour cherry clones we differentiated three types of floral secretion on the basis of the highest production values (Orosz Kovács et al., 1989).

Material and Method

We carried out the examination of the floral nectar secretion of protogyn sour cherry varieties between 1988—1991 at the Research Station of Fruit — and Ornament Plant Growing and Research Company in Cegléd and in the orchard in Ceglédbercel belonging to the South-Pest County Stone-fruit Growing Company. We observed with attention the development of stigma surface of the Érd type with large fruit from the green bud stage to the opened flower. The beginning of nectar secretion, the formation of nectary surface in the same stages of development were studied in the M—18 protogyn sour cherry type. To examine the stigma and nectary surface the fresh material was fixed in 3% glutaraldheid, and the washing was done in 0,1 mol. Na-kakodilat puffer. The fixed material was dehydrated in ethylic alcohol series. At a critical point drying and gold shadowing were done. The micro-photos were taken with help of ASID—4 SEM adapted to yeol 100 — C in 1000—10 000 magnification.

Results

The changing of pollination strategy is characteristic for sour cherries with protogyn flowers. Two forms of function ability of stamina and pistil can be found in them, namely true dichogam protogyny and "delayed" homogamy (pseudodichogamy) beginning with protogyny.

The flowers of sour cherry of Érd type with large fruit are true protogyn. The stigma is already mature 6—10 days before blossoming. On the exerted stigma surface streching out of the green bud stigma secretion can be observed at 3 and 15 o'clock — according to the time of secretion rhithm. The receptivity of stigma begins already at a 3—5 mm size of the bud. The stigma papills are

already totally developed in their green bud stage (Fig. 7—8.), their surface is turgorous, the stigma surface is mature for pollination. The reproduction organ in this stage of development is not attractive for the insects at all. The stamina in the closed bud are unmature, nectar secretion does not begin yet. On the nectary surface we can see that the stomas through which the fluid of secretion emerges are closed, the cuticle has not burst open yet (Fig. 1.). The only way of pollination is: the wind as mediatory. The stigma exerted and the relatively large stigma surface also refer to this fact. The glitter of stigma surface may indicate some beetle attraction but no beetles were seen on the stigma streching out of the bud during the time of examination.

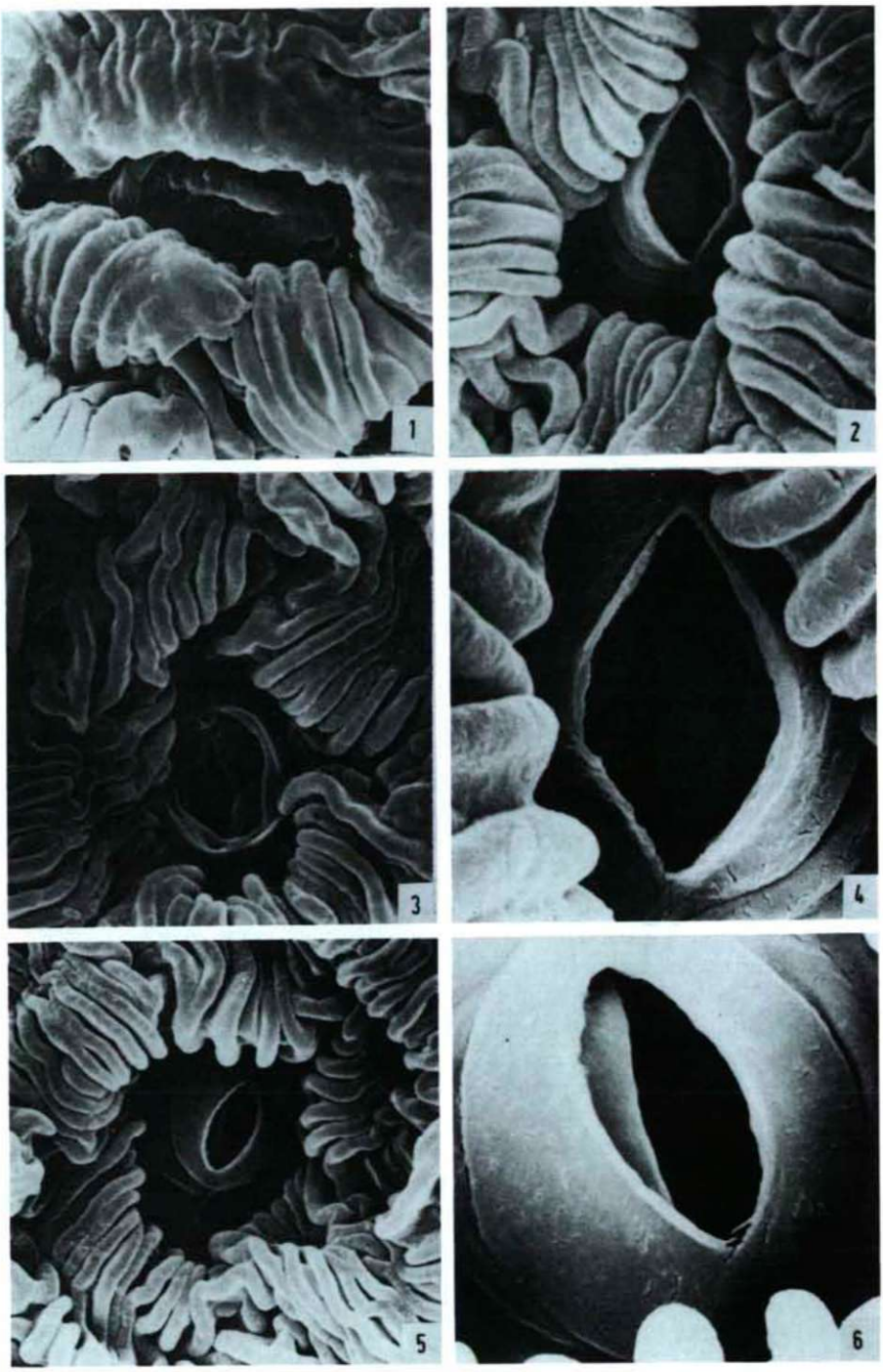
The degeneration of stigma papills begins unusually very soon. At the end of the green bud stage papills lose from their turgors, slight creases (crumplings) can be seen (Fig. 9.) but they cannot possibly prevent pollination.

The green bud stage is soon floowed by the "pollination chamber" stage. The petals grow on and reach the hight of stigma where they form a circle like orifice giving room for the stigma to drive in. During the time of "pollination chamber" stage — which in GOTTSBERGER's opinion (1977) is characteristic for each of the protogyn *Prunus* and *Pyrus* varieties — the pollination is done by cantharofil beetles. In our observations the scent of flowers of the pollination chamber in the sour cherry of Érd variety with large fruit resembels that of rotting fruit and the same findings were described by PILJ (1961) and GOTTSBERGER (1974, 1977). The scent exciting the cantharofil beetles, as well as the characteristic white colour of the flowers (petals) and the green one (nectary, stigma) confirm the possibility of beetle pollination. In the opinion of the authors mentioned before beetles living in the flower of openig bud stage feed themselves with stigma secretion, nectar, pollen, petals and may significantly damage the flowers. The pollination is possibly carried out by pollen stuck to the beetles legs wet with stigmatic secretion (GOTTSBERGER, 1977).

Nectar secretion in the flower begins in the "pollination chamber" stage. Secretion rushing up through the stoma lifts and tears the cuticle covering the nectary stoma (Fig. 2—4.). The "pollination chamber" stage may go on for 1—3 days depending on the weather. In this flower stage the nectar is very diluted, the dry matter is below 10%. Secretion of so low calori value is not attractive at all for the bees, and they did not attend flowers of opening bud stage. A considerable number of smaller beetles can be seen in buds of this stage.

By the end of the "pollination chamber" stage the stigma papills shrivel (Fig. 10.) and when the flower opens the stigma surface is not suitable for the reception of pollen.

Nectar secretion which started in the "pollination chamber" stage of stigma phase works by a regular rhithm. Nectar is produced twice a day at 03 and 15 o'clock, that is in a 12 hour interval (Fig. 11.). The secretion at dawn attracts night insects while that early in the afternoon the daily ones. In the young, opened flowers the stigma is already turning brown, but the nectar is still delute, not attractive for the bees. If the weather is cool, it may happen that the insects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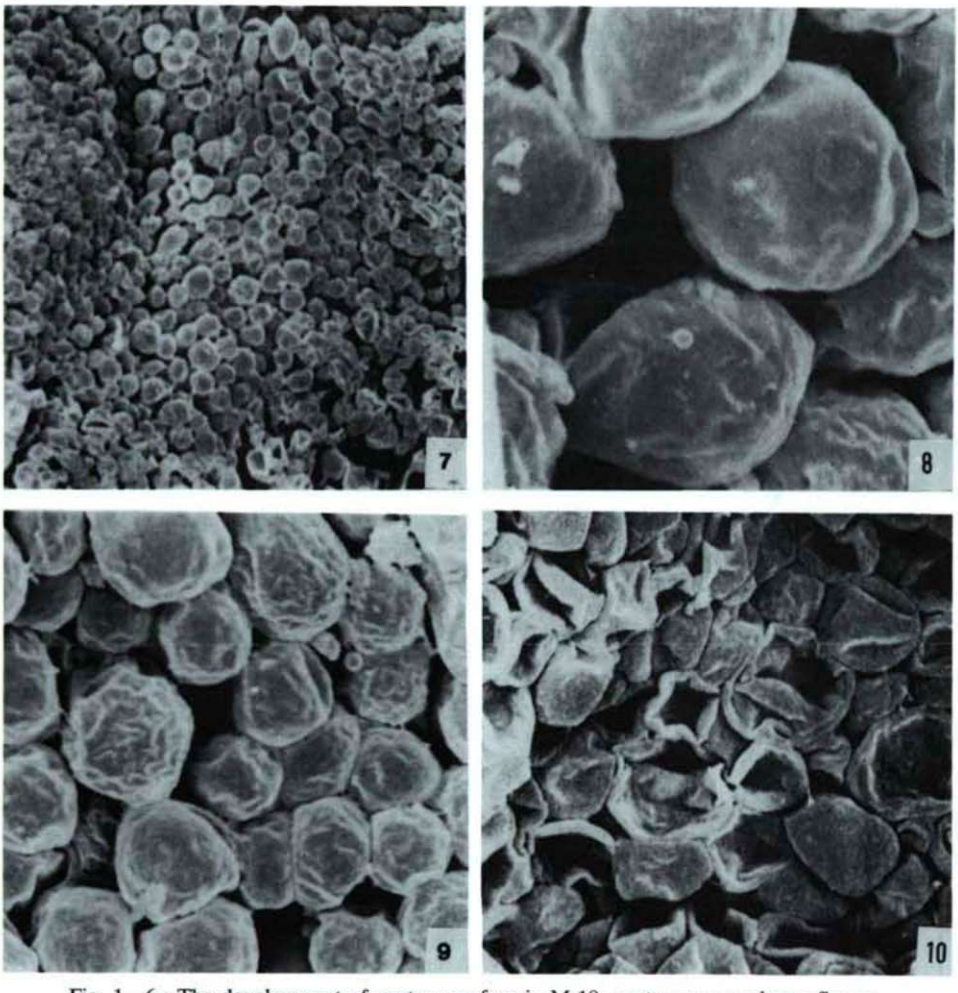

Fig. 1—6.: The development of nectary surface in M 18. protogyn sour cherry flower during blossoming.

1. In closed, green bud stage: the closing cells of the stoma have not opened yet, the cuticle covering the stoma has not torn (SEM 300 x)

2—4. In the pollination chamber stage when nectar secretion begins, the cuticle tears above the stoma, the closing celles become visible (SEM 3000 x, 10 000 x).

5—6. The stoma of nectaries in the flower with open anthers is open (SEM 3000 x, 10 000 x).

Fig.. 7—10. : The changing of stigma surface in the protogyn flower of Érd sour cherry with large fruit during the development of the flower.

7—8. In green bud stage the papills of stigma exerted are wholly developed, trugorous, (SEM 300 x, 3000 x).

9. By the and of the green bud stage the surface of papills begins to crease (SEM 1000 x).

10. During the formation of pollination chamber a significant part of the stigma surface died (SEM 1000 x).

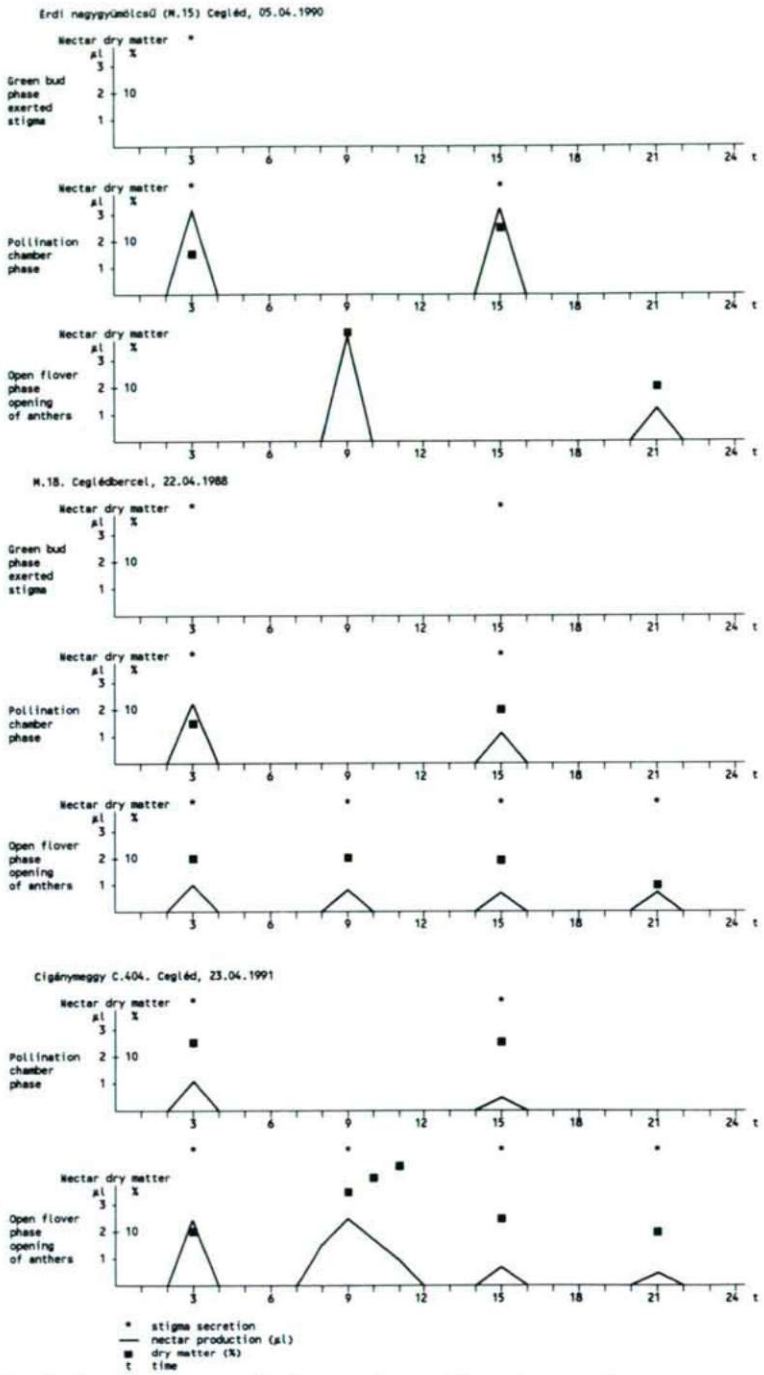

Fig. 11. The rhythm of nectar secretion in sour-cherry with protogynous flowers.

do not consume the secretion produced in the bud and during 2—3 days it is concentrated so much that the dry matter exceeds 10%. In warm weather (about 20 C°) the dry matter of the young flower secretion exceeded 20% in some cases. This time it may happen that the bees visiting the flowers for nectar touch the stigma when streching down to the receptacle through the nectar guide and it may be probable that successful fertilisation can still be realized in this young flower stage described by STÖSSER (1985).

The flowers of sour cherry of Érd variety with large fruit are visited by bees mostly during the opening of anthers. This time the stigma surface is wholly brown. The flower excludes self pollination with true dichogamy. Now the bees have a role not in supplying the stigma with pollens but in sending them away. During the opening of anthers the floral secretion rhithm changes. Nectar is produced by 12 hours as previously (Fig. 11.) but the production maximums are shifted by 6 hours, i. e. secretion takes palce at 09 and 21 o'clock, one at daytime one at night. The nectar concentration is already suitable for the bees and the flowers are visited beside bees by other insects too.

The flowers of Érd autosterile sour cherry variety with large fruit change pollination strategy three times. At the beginning of blossoming they avoid selfpollination with the earlier mature stigma exerted and due to the lack of insect attraction they are pollinated by wind. In the "pollination chamber" stage beetle pollination comes into prominence and finally the third changing of strategy takes place at the opening of the flower, when during the opening of anthers the pollen transport by bees and different insects takes place. The pollination of flowers of this variety may be done essentially during the first two stages.

The protogyn of M. 18 sour cherry flowers is partially different from the previously described one. The first strategy here too is based on pollination by wind in green bud stage, in exerted stigma state. The "pollination chamber" stage ensuring the conditions of beetle pollination can be found too. The difference, if compared with the previous variety, is that the stigma retains its receptivity during the whole life of the flower. So during the opening of anthers the stigma has still its vitality, and as a autofertile type, it may be fertilized by its own pollens. The aim of the changing of strategy here is to bring about genetic refreshment, and in case of failure it shows the direction of getting pollens by all means.

The rhithm of nectar secretion indicates the first separated then the joint operation of stamina and the pistil. Similary to the dichogam flowers of the Érd variety with large fruit here nectar production begins also in the pollination chamber stage at 03 and 15 o'clock (Fig. 11.). In the opened flowers, however, in the time of opening of anthers the 6 hour rhithm characteristic for homogamous flowers (works), i. e. the production maximums appear at 03, 09, 15 and 21 o'clock. According to the autofertile varieties the amount of secretion is low.

The flowers of M.18 sour cherry clone are not really true dichogam. The initial separation of stamina and pistil is soon followed by homogamy. The

synchronized, joint work of genital leaves entering later is called "delayed" homogamy.

Similary "delayed" homogamy can be seen in the C. 404 clone of Cigánymeggy (Gipsy sour cherry) whose flowers do not have the characteristic exerted stigma stage. The maturity of flower suitable for pollination begins in the "pollination chamber" stage and after the dichogam phase the stamen and pistil turn into homogamy during the opening of anthers (Fig. 11.). The autofertile type is pollinated with extraneous pollens during blossoming. If it does not occur, self-fertilisation may take place in the homogam phase. The latter phenomenon can be observed at the end of blossoming when the mature anthers very often hang over the stigma. We observed these "delayed" homogam flowers in our earlier work too, e. g. similar phenomenon was experienced in the variety of Újfehértó racemose (Orosz Kovács et al. 1989.).

Each of the above mentioned varieties had the same secretion rhithm, the maximums of nectar production — synchronized with the opening of anthers and receptivity of stigma were at 3, 9, 15 and 21 o'clock. Summerizing our results it can be said that the pollination of protogyn sour cherry varieties may be realized by multi-changing of pollination strategy: e. g. in green bud stage, in stigma exerted stage by wind, and finally in pollination chamber stage by beetles and finally in the open flower with open anthers by bees and other insects. Protogyny occurs in both autosterile and autofertile varieties. In some autosterile varieties the phase of receptivity of stigma and the opening of anthers is totally separated. During the time of blossoming the stigma surface is already degenerated and besides the 12 hour periodicity of nectar secretion also indicates dichogamy. In the autofertile varieties protogyny is indicated by the stigma exerted or the pollination chamber stage accompanied by a 12 hour dichogam secretion rhithm. Dichogamy is characteristic only during blossoming, the flowers turn into homogamy at the opening of anthers which can be seen in the 6 hour nectar secretion rhithm and the prolonged receptivity of stigma. These flowers of "delayed" homogamy (pseudohomogamy) may be fertilized by self-pollination at the end of blossoming.

The quick changing of pollination strategy of flowers, variability in one fruit type make the application of flower biological observations justified in the planning of up-to date mixed planting of the fruit trees.

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